

A Brief Description of CoSSIR

CoSSIR (Conical Scanning Submillimeter-wave Imaging Radiometer) is a relatively new airborne radiometer assembled for CRYSTAL-FACE. Table 1 summarizes the characteristics of this new instrument. It has fifteen channels; nine of them at the frequencies of 183.3 ± 1 , 183.3 ± 3 , 183.3 ± 6.6 , 220, 380 ± 0.8 , 380 ± 1.8 , 380 ± 3.3 , 380 ± 6.2 , and 640 GHz are horizontally polarized, and the remaining six are dual-polarized at three frequencies of 487 ± 0.7 , 487 ± 1.2 , and 487 ± 3.3 GHz. The beam width is about 4° and frequency independent. Two close-coupled external blackbody calibration references at the temperatures of ~ 250 and ~ 330 K (which are measured to an uncertainty of ± 0.1 K) provide accurate calibration of the radiometric measurements. The CoSSIR's widely separated groups of frequencies at 183.3, 220, 380, 487, and 640 GHz are well suited for the retrievals of D_{me} (median mass equivalent sphere diameter) and IWP (Ice water path) of cirrus clouds. The dual polarization capability at 487 GHz has the potential of inferring the shape of ice particles. Furthermore, the multi-channel measurements around the water vapor absorption lines of 183.3 and 380 GHz will provide retrievals of water vapor profiles. The temperature sensitivity of the instrument with 100 ms integration time should be ≤ 0.7 K at all channels and the calibration accuracy will be about ± 1.0 K in the T_b range of 200-300 K. Analysis of the instrument characteristics suggests that the accuracy of T_b depression will be on the order of 1 K, and the threshold of IWP detection for particles with $D_{me} \sim 100$ μm will be as low as ~ 10 g/m^2 and ~ 5 g/m^2 at 487 and 640 GHz, respectively (Evans et al, 1998).

Figure 1 below shows the compactness of the scan head of the CoSSIR when it was first assembled in the laboratory. The scan head cylinder is only ~ 28 cm long and ~ 21 cm in diameter and contains all the receivers, signal conditioning electronics, data system and power conditioning circuitry. The compact design lends itself to other integration configurations such as on an unmanned aerial vehicle. The figure displays part of the fully assembled CoSSIR ready for a laboratory liquid nitrogen test; the scan head with its 6 antennas is clearly exposed. The scan head is rotated by a two-axis gimbaled mechanism capable of generating a wide variety of scan profiles. In the conical scanning mode the azimuth axis rotates the antenna patterns at 6 rpm to generate the conical scan while at the same time the elevation axis maintains the antenna pointing at the prescribed angle of incidence. Twice during each rotation of the azimuth axis, calibration is performed followed by a cross track scan. The elevation axis is used to rotate the antennas to point at the calibration references and then to sweep the antenna patterns through nadir back to the prescribed incidence angle.

Figures 2 and 3 compare sample brightness temperature (T_b) images from several selected channels of the CoSSIR with those from the MAS, CPL, and CRS. The data were acquired from the transit flight to Key West, Florida on July 1, 2002.

Table 1. CoSSIR characteristics

Center Frequency (GHz)	Bandwidth (MHz)	Trec (K)	Noise Figure (dB)	NEΔT for $\tau=100$ ms @ 200K (K)	Beamwidth (degrees)	Polarization
183.31 ± 1	500	1341	7.5	0.22	4	H
183.31 ± 3	1000	1341	7.5	0.15	4	H
183.31 ± 6.6	1500	1341	7.5	0.13	4	H
220	3000	1418	7.7	0.09	4	H
380 ± 0.8	700	3361	11	0.43	4	H
380 ± 1.8	1000	2964	10.5	0.32	4	H
380 ± 3.3	1700	2964	10.5	0.24	4	H
380 ± 6.2	3600	2964	10.5	0.17	4	H
487 ± 0.7	400	4306	12	0.71	4	H and V
487 ± 1.2	900	4306	12	0.44	4	H and V
487 ± 3.3	3000	4306	12	0.26	4	H and V
640	3000	4306	12	0.26	4	H

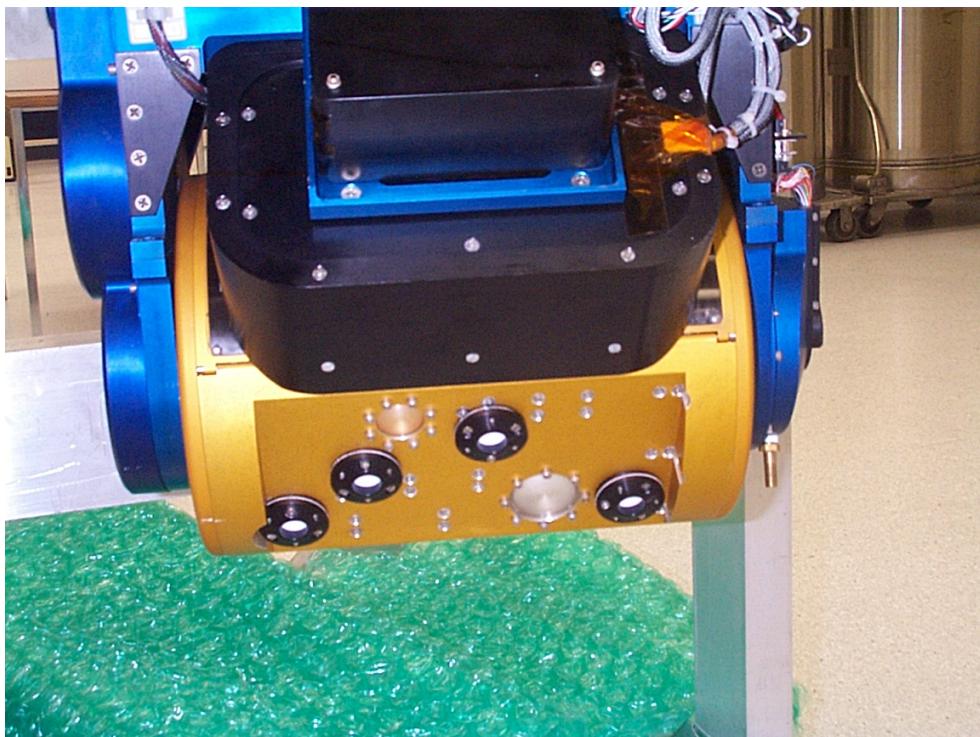


Figure 1. A front view of CoSSIR as it was prepared for a liquid nitrogen test in the laboratory.

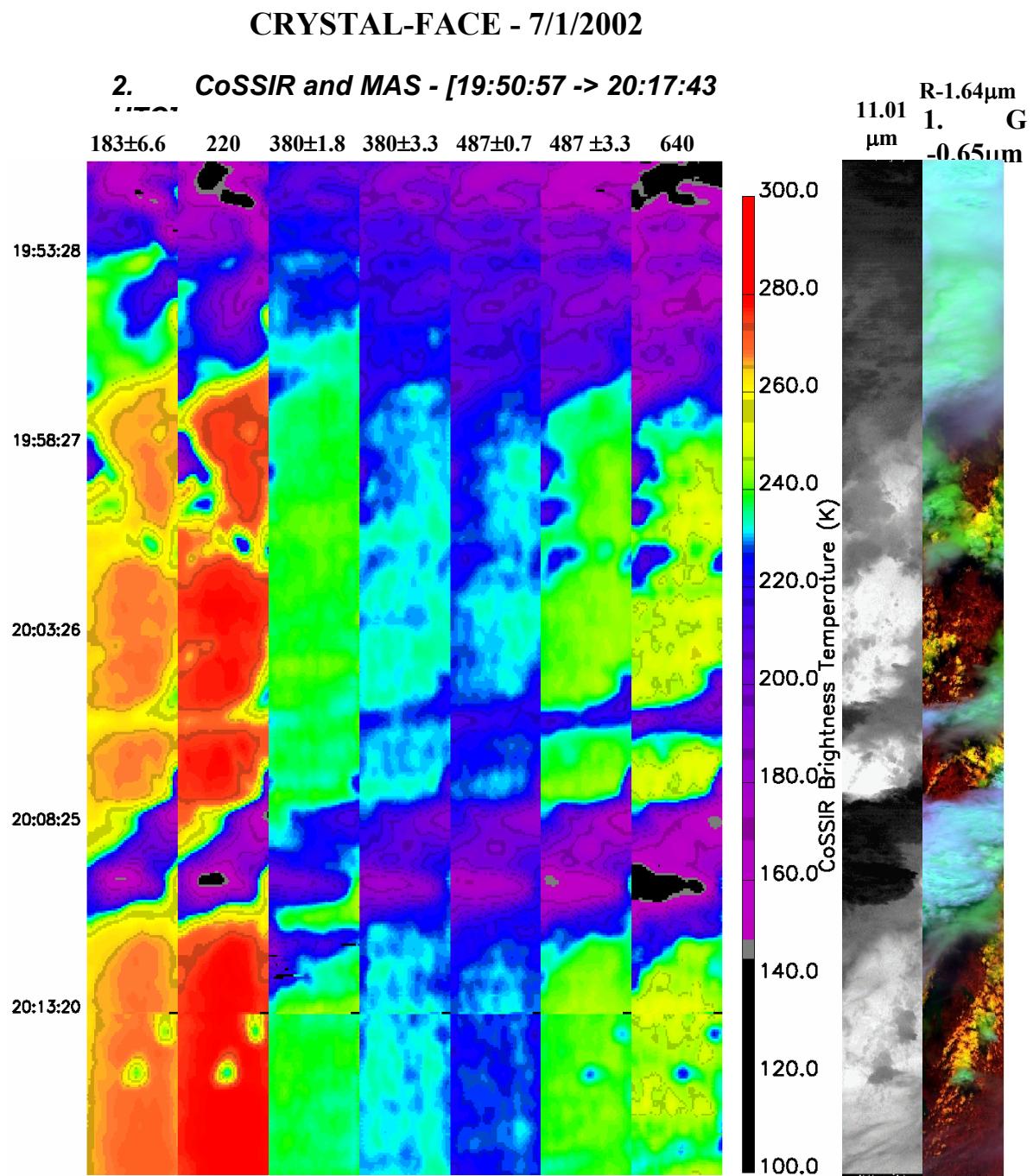
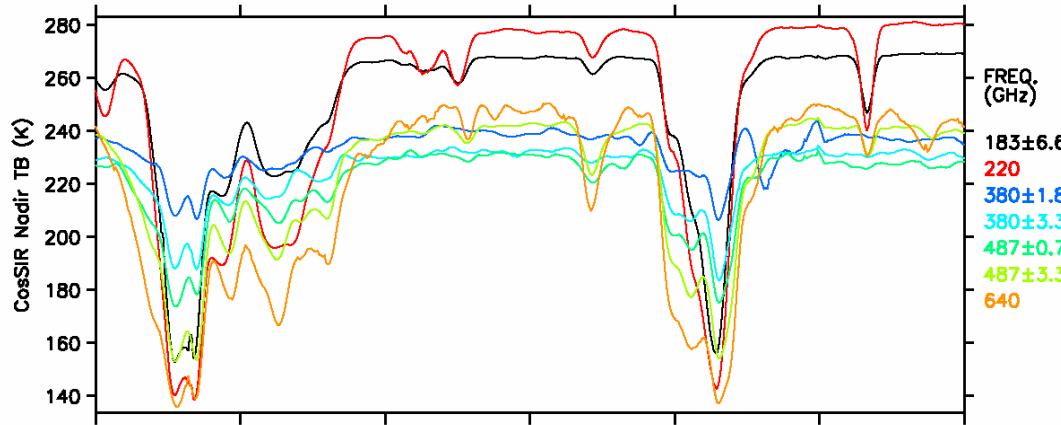


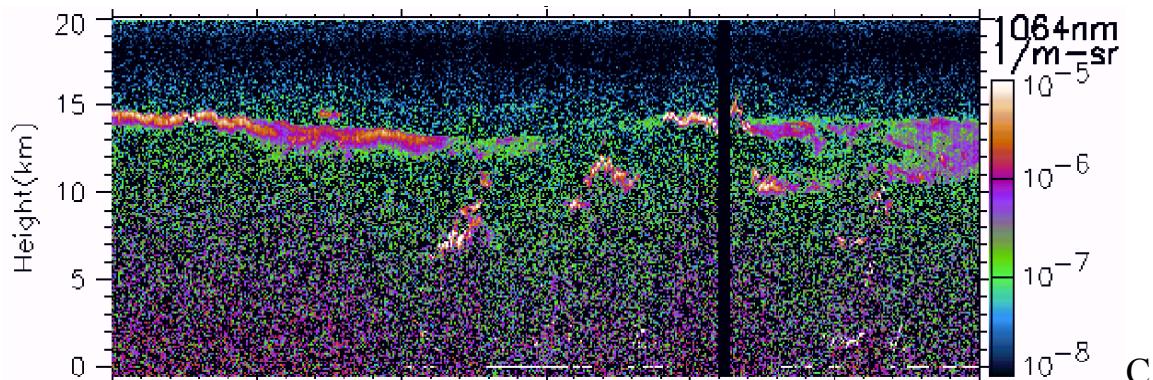
Figure 2. Pseudo color images of brightness temperatures from selected channels of CoSSIR and MAS.

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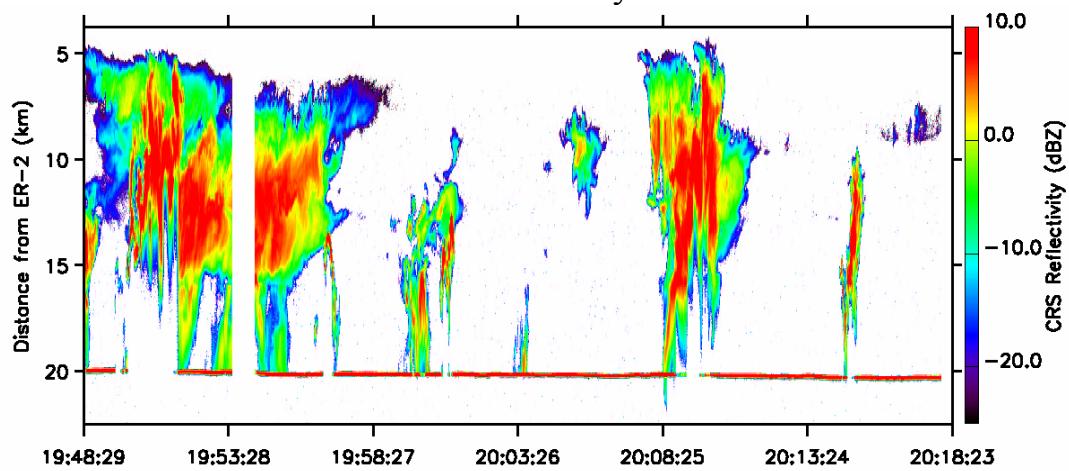
Conically Scanning Submillimeter-wave Imaging Radiometer



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Figure 3. A comparison of CoSSIR nadir brightness temperature variations with CRS reflectivities and CPL signal returns.

